FISHERY DATA SERIES NO. 73

# EVALUATION OF STOCKED WATERS IN THE TANANA DRAINAGE, 1987[1]

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November 1988
Reprinted June 1990

[1] This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-3, Job No. T-8-1.

TABLE OF CONTENTS

LIST OF TABLES

## LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

This report presents the results obtained during the evaluation of the Region III lake stocking program performed in 1987. A combined total of 3,320,994 rainbow trout *Oncorhynchus gairdneri*, Arctic grayling *Thymallus arcticus*, coho salmon *Oncorhynchus kisutch*, chinook salmon *Oncorhynchus tshawytscha*, sheefish *Stenodus leucichthys*, and Arctic char *Salvelinus alpinus* were stocked into 80 lakes and ponds in interior Alaska. The request for 1988 is 2,415,950 fish to be stocked in 47 waters.

Mark-recapture estimates of rainbow trout abundance were performed at Birch and Quartz Lakes. An estimated 55 percent and 14 percent, respectively, of subcatchable rainbow trout survived from June 1987 (when they were stocked) to August 1987. Mark-recapture estimates of rainbow trout fingerling overwinter survival rates ranged from 14 percent to 83 percent in a series of smaller lakes. Chinook salmon survival rates in two small lakes were similarly estimated at 32 percent and 30 percent.

Little evidence of stocked fish other than lake trout *Salvelinus namaycush* was found during test netting of Harding Lake. Preliminary results indicate that rainbow trout stocked in Piledriver Slough survived during the winter of 1987-1988.

KEY WORDS: stocked lakes, Birch Lake, Quartz Lake, population estimates, survival, growth.

## INTRODUCTION

The Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) stocks numerous lakes and ponds in interior Alaska with rainbow trout *Oncorhynchus gairdneri*, coho salmon *Oncorhynchus kisutch*, Arctic grayling *Thymallus arcticus*, Arctic char *Salvelinus alpinus*, and chinook salmon *Oncorhynchus tshawytscha*. These stocked lakes are an important component of the area fisheries, supporting over one-third of the recreational angling in the Tanana River drainage. The stocking program in interior Alaska is conducted in an approximate 150,000 square km area bordered by the Kantishna River on the west, the Tok area to the east, the Delta River drainage south to Black Rapids, and the Steese Highway area north to the town of Central (Figure 1). Most of the stocked lakes are near communities and along road systems, but a number of remote stocked lakes are accessible only by dog team, all terrain vehicle, snow machine, or airplane.

Increasing human population in the Tanana Valley is putting a greater demand on limited sport fishing opportunities. Temporal and financial constraints cause the majority of fishermen to favor roadside fisheries over more remote angling opportunities. Thus, native fish populations near the Interior road system are receiving heavy angler utilization. The fish stocking program in interior Alaska has been successful in diverting some angling effort away from native stock fisheries. In 1986, an estimated 55,323 stocked rainbow trout and coho salmon were harvested by Tanana Drainage anglers (Mills 1987). The stocking program also increases recreational opportunity during the winter. Over half of the yearly sport fishing effort on the large, accessible stocked lakes takes place in the winter.

To provide more year round fishing opportunities and to shift pressure away from heavily utilized wild stocks, ADF&G is expanding its lake stocking program to include new waters and new species. In 1988, an anticipated 1,169,600 rainbow trout, 264,600 coho salmon, and 89,350 grayling will be stocked. These "production" stockings will be augmented by experimental stockings of 72,600 Arctic char, 49,400 lake trout *Salvelinus namaycush*, 45,400 chinook salmon, and 500,000 kokanee *Oncorhynchus nerka*. Some experimental stocking (225,000) of sheefish *Stenodus leucichthys* will be continued in 1988, but success to date of sheefish enhancement has been poor.

Quartz and Birch Lakes are the largest fisheries in terms of effort in interior Alaska, contributing up to 75% of the harvest of rainbow trout. Therefore, a significant amount of effort has been devoted to estimating optimum stocking parameters (numbers, size, timing, and strain) in these lakes. For example, experimental stocking of 20 g subcatchable Swanson strain rainbow trout into Birch Lake was begun in 1980 and 1981. This resulted in higher fish survival rates and higher harvests than were obtained from fish stocked as fingerlings in 1983, 1984, and 1985 (Doxey 1985). Subsequently, stocking of subcatchable rainbow trout has been expanded to include Quartz Lake. Evaluation of the success of this experiment is continuing.

Stocking success in smaller lakes is evaluated intermittently. The level of evaluation varies according to the size and accessibility of the lake, the importance and intensity of the sport fishery, and the research needs for the

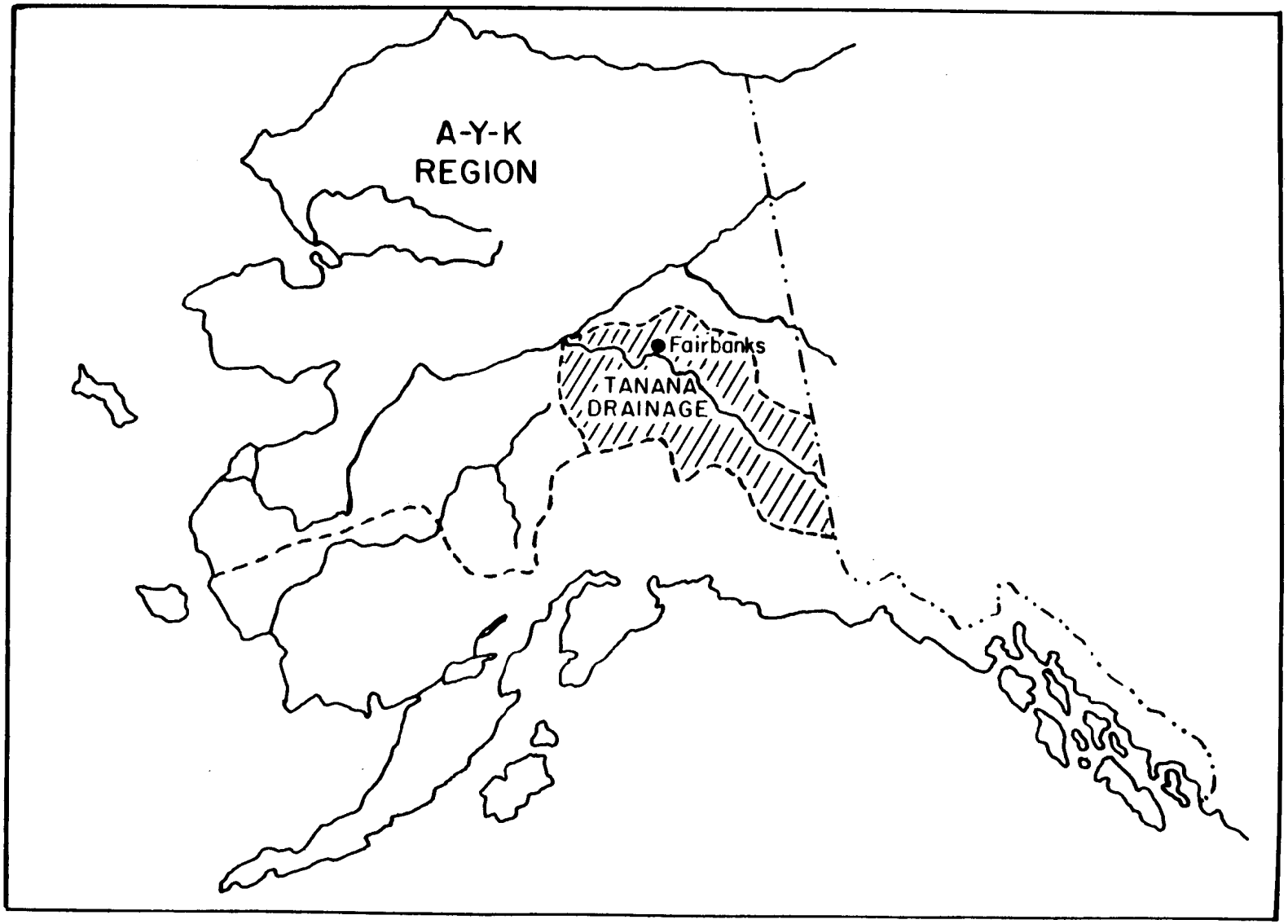


Figure 1. Fairbanks area lake stocking study area.

species stocked into the lake. Minimal evaluations involve overnight net sets, and answer the question of whether the stocked fish survived and whether they have reached catchable size.

The major goal of the stocking program is to create, maintain, or improve a variety of sport fishing opportunities in the region. Specific project objectives in 1987 were as follows:

1. to estimate abundance, mean length, and cohort composition of rainbow trout and coho salmon in Birch Lake and Quartz Lake;

2. to estimate rainbow trout abundance, mean length, and cohort composition in Jan Lake, Robertson Number Two Lake, North Twin Lake, South Twin Lake, Bathing Beauty Pond, and 45 Mile Chena Hot Springs Road Pit;

3. to estimate chinook salmon abundance, mean length, and cohort composition in Bolio Lake and Little Harding Lake;

4. to document presence and average size of rainbow trout in Manchu Lake, Johnson Road Pit Number One, Thirty-one Mile Pit, and Piledriver Slough;

5. to document presence and average size of landlocked coho salmon in Manchu Lake, Twenty-eight Mile Pit, Thirty-one Mile Pit, and Johnson Road Pit Number One;

6. to estimate average length of Arctic char 1 year after stocking in Trap Lake;

7. to document the presence of stocked sheefish in Silver Fox Pit, Weigh Station Pond Number One, Weigh Station Pond Number Two, and Ghost (formerly Gull) Lake; and,

8. to document the spatial distribution of sheefish in Harding Lake.

A major task of the lake stocking project is to formulate future stocking procedures and to assist Fisheries Rehabilitation, Enhancement, and Development (FRED) Division with stocking all area lakes. Results of these activities are also presented in this report.

## METHODS

Project research activities in 1987 fall into two major categories: mark-recapture experiments and test netting evaluations of stocking success.

### Mark-Recapture Experiments

Abundance of stocked fish using mark-recapture experiments was estimated by species at the locations and times listed in Table 1. Fish were captured with fyke nets baited with salmon eggs. Fyke nets were 6.1 m long and 1.2 m in

Table 1. Lakes on which population abundance estimates were accomplished during 1987.

| Lake | Species | Date |
|---|---|---|
| Birch | Rainbow Trout | 20 August |
| Quartz | Rainbow Trout | 23 September |
| Bathing Beauty | Rainbow Trout | 15 June |
| 45.5 Mi. CHSR[1] | Rainbow Trout | 12 June |
| Jan | Rainbow Trout | 8 July |
| North Twin | Rainbow Trout | 25 June |
| South Twin | Rainbow Trout | 25 June |
| Bolio | Chinook Salmon | 25 June |
| Little Harding | Chinook Salmon | 23 June |
| Robertson Lake #2 | Rainbow Trout | 8 July |

[1] Chena Hot Springs Road

diameter with 9.53 mm knotless nylon webbing and 1.2 m x 30.5 m center leads. Center leads were attached to shore and the nets were set perpendicular to shore in about 0.5 m to 2 m of water. All captured fish were anesthetized with MS-222, marked with a partial clip of a lobe of the caudal fin, measured to the nearest millimeter fork length (FL), and released away from the site at which they were captured. Initial marking generally took place over 4 days. Subsequent sampling took place after a 1 to 4 week period to allow marked fish to mix throughout the population. All captured and recaptured fish were measured as described above and released. At Quartz Lake, subcatchable rainbow trout were marked prior to stocking with adipose finclips (so that they could be distinguished from fish stocked as fingerlings).

At Quartz and Birch Lakes, four to six fyke nets were fished during each sampling event. To allow assessment of mixing of marked and unmarked fish at Quartz and Birch Lakes, fish captured on one half of the lake were marked with an upper caudal finclip and those captured on the opposite half of the lake were given a lower caudal clip. Sampling in all other lakes (Jan, Robertson Number Two, North Twin, South Twin, Bolio, and Little Harding) was similar to that of Quartz and Birch Lakes except that only two or three fyke nets were set at each lake and fish were not given differential finclips in each half of the lake.

The preferred population abundance estimator was Chapman's modification of the Petersen mark-recapture technique (Chapman 1951):

$$(1)\quad \hat{N} = \frac{(n_1 + 1)(n_2 + 1)}{R + 1} - 1;$$

where:

$\hat{N}$ = the estimated abundance;

$n_1$ = the number of marked fish in the population;

$n_2$ = the number of fish caught in the second sampling event; and,

$R$ = the number of marked fish caught in the second sampling event.

The approximate variance of this estimate is:

$$(2)\quad V[\hat{N}] = \frac{\hat{N}(n_2 - R)\,(n_1 - R)}{(R + 1)\,(R + 2)}.$$

Assumptions necessary for the accurate use of these estimators are:

1. the population is closed (no immigration or emigration);

2. all fish have the same probability of capture in the marking sample or in the recapture sample, or marked and unmarked fish mix completely between marking and recapture events;

3. marking does not affect their probability of capture in the recapture event;

4. fish do not lose their mark between the marking and recapture events; and,

5. all marked fish are reported when recovered in the recapture sample.

Validity of these assumptions was tested with a battery of chi-square and/or Kolomogorov-Smirnov tests generated from the mark-recapture data (Seber 1982).

In several of the lakes, the fish population was made up of more than one stocking cohort (year class or stocking size group). The proportions of fish in all stocked cohorts were simultaneously estimated as multinomial and binomial proportions. The proportions of each category were estimated as follows (Cochran 1977):

$$(3)\quad \hat{P}_j = \frac{n_j}{n}; \text{ and,} \qquad (4)\quad V[\hat{P}_j] = \frac{\hat{P}_j(1-\hat{P}_j)}{n-1};$$

where:

$n_j$ = the number in the sample from group j;

$n$ = the sample size; and,

$\hat{P}_j$ = the estimated fraction of the population that is made up of group j.

Numbers of fish sampled from each stocked cohort were determined through length frequency analysis. For the Birch Lake estimate, in which there was considerable overlap in the length ranges of the identifiable stocking cohorts, proportions of samples by stocking cohort were estimated with software package NORMSEP from the Southwest Fisheries Center, National Marine Fisheries Service, La Jolla, California. This program is designed to separate mixed populations of normally distributed fish lengths according to the procedures of Hasselblad (1966).

The abundance of survivors in each stocking cohort is the product of the estimated fraction and estimated abundance of the population:

$$(5)\quad \hat{N}_j = \hat{N}\ \hat{P}_j .$$

The variance of this equation is the product of two variances according to Goodman (1960):

$$(6)\quad V[\hat{N}_j] = \hat{N}^2\, V[\hat{P}_j] + V[\hat{N}]\ \hat{P}_j^2 - V[\hat{P}_j]\ V[\hat{N}]\ .$$

The survival rate since stocking and associated variance for each cohort was calculated as follows:

$$(7)\quad \hat{S} = \frac{\hat{N}_2}{N_1};\ \text{and,} \qquad (8)\quad V(\hat{S}) = \frac{V(\hat{N}_2)}{N_1^2};$$

where:

$N_1$ = number of fish stocked;

$\hat{N}_2$ = the estimated abundance of the stocking cohort; and,

$\hat{S}$ = the estimated survival rate from the time of stocking to the time of the abundance estimate.

Estimates of mean length of each stocking cohort were generated with standard normal procedures. Simple averages and squared deviations from the means were used to calculate means and variances of the means.

Test Netting

Length and relative abundance information of stocked fish was collected incidental to major population estimates or as time allowed in several small lakes (Lost Lake, Geskakmina Lake, Dune Lake, Manchu Lake, Ghost Lake, Trap Lake, Bolio Lake, South Twin Lake, 28 Mile Pit, 31 Mile Pit, Johnson Road Pit Number 1, Silver Fox Pit, Weigh Station Pond Number 1, and Weigh Station Pond Number 2; see Table 2). These data were obtained by overnight sampling with fyke and gill nets, spot check creel census interviews, or by hook and line sampling. Gill nets were monofilament experimental sinking nets with overall dimensions of 38.1 m x 1.8 m consisting of five 7.6 m long panels of 12.7 mm through 63.5 mm bar mesh.

Test netting of Harding Lake was performed to determine if sheefish stocked in prior years had survived. Fyke nets and experimental gill nets (sinking and vertical sets) were fished in a 4-night block each month from June through early October in Harding Lake. The lake was divided into four pie-shaped sample areas. During each trip, a fyke net was fished from shore in each sampling area (a total of four nets). Four sinking variable mesh gill nets were fished perpendicular to the shore in an evenly spaced line from about 7 m of water out to the deepest water in the quadrant (20-40 m). The depth of each set was verified using a recording fathometer. Six vertical gillnets were

Table 2. Waters in which growth and relative abundance sampling was performed during 1987.

| Lake | Species | Date |
|---|---|---|
| Bolio | Grayling | June |
| Lost | Coho Salmon | July |
| South Twin | Chinook Salmon | June and August |
| Geskakmina | Coho Salmon | April |
| Dune | Coho, Grayling, Rainbow Trout | April |
| Manchu | Rainbow Trout, Coho | June |
| Ghost | Sheefish | August, 1986 |
| Trap | Arctic Char | August |
| 28 Mile Pit | Coho Salmon | June |
| 31 Mile Pit | Coho Salmon | July and October |
| Johnson Road Pit #1 | Coho Salmon | July |
| Silver Fox Pit | Sheefish | July |
| Weigh Station Pit #1 | Sheefish | July |
| Weigh Station Pit #2 | Sheefish | July |

used to sample midwater habitats in the deeper water of each quadrant. The ten gillnets were fished in a quadrant for 1 night, then moved to the next quadrant until all four quadrants were sampled.

Catches of all game fish were recorded by species, gear type, depth, and location. Fork length to the nearest millimeter was recorded for all species captured except least cisco *Coregonus sardinella*. Weights of lake trout and large sheefish were visually estimated as the fish were released. Incidentally caught northern pike *Esox lucius* and lake trout were also marked with individually numbered Floy tags so that individual recaptures could be identified. Dead fish were autopsied to determine sex, maturity, and age. Structures taken for age determination included: scales (all species except burbot *Lota lota*), otoliths (burbot and lake trout), cleithrum bones (northern pike), vertebrae (burbot and northern pike), and opercles (lake trout).

In 1987, three size classes of rainbow trout were stocked into Piledriver Slough. This was the first ever stocking of rainbow trout into an interior Alaska river. To determine whether these fish can overwinter in the system, creel census interviews and sampling of the stream using seines and electrofishing gear were performed in the spring of 1988.

## RESULTS

### Numbers of Fish Stocked

A total of 1,875,553 rainbow trout, 833,796 Arctic grayling, 247,874 sheefish, 4,153 Arctic char, 37,718 chinook salmon, and 321,900 coho salmon were stocked in Region III waters in 1987 (Appendix Tables 1 through 6). No major logistical problems or fish mortalities occurred during stocking. Fish were transported to remote lakes by Sport Fish Division personnel using an all terrain vehicle, commercial and military helicopters, and state and private aircraft.

Anticipated totals of 1,169,600 rainbow trout, 264,600 coho salmon, 89,350 grayling, 72,600 Arctic char, 49,400 lake trout, 45,400 chinook salmon, 500,000 kokanee salmon, and 225,000 sheefish will be stocked in Region III waters in 1988 (Appendix Table 7).

### Mark-Recapture Experiments

Mark-recapture experiments to evaluate the survival of stocked rainbow trout, coho salmon, and chinook salmon were attempted in ten lakes during 1987 (Table 1).

Birch Lake Rainbow Trout:

Almost 4,700 rainbow trout were sampled during the mark-recapture experiment at Birch Lake (Table 3). However, contingency table analyses indicated that sampling was biased. First, the ratios of tagged to untagged fish in the second sampling event were significantly different in each half of the lake ($\chi^2 = 37.11$, $df = 1$, $p < 0.001$). In addition, marked fish did not mix completely with unmarked fish across the lake ($\chi^2 = 28.13$, $df = 2$, $p < 0.001$).

Table 3. Numbers of rainbow trout sampled and estimated abundance from the mark-recapture experiment at Birch Lake, 1987.

| Cohort | Number Marked | Number Examined | Number Recaptured | Estimated Abundance | Standard Error |
|---|---|---|---|---|---|
| Total Population | 1,970 | 2,718 | 313 | 26,556 | 4,791 |
| 1987 Subcatchables | (Apportioned from total population estimate using NORMSEP - see text) | | | 18,589 | 786 |
| All other Rainbow Trout | (Apportioned from total population estimate using NORMSEP - see text) | | | 7,967 | 765 |

Thus, the assumption of equal probability of capture/random mixing was violated. Therefore, the stratified estimator of Darroch (1961) was employed to estimate rainbow trout abundance at 26,556 fish (Table 3).

Length frequency analysis (NORMSEP) defined two predominant cohorts of rainbow trout in Birch Lake: (1) subcatchables stocked in 1987, and (2) older rainbow trout stocked in prior years. An estimated 70% of the population was composed of subcatchables stocked in 1987 with the remaining 30% being older fish. Therefore, the estimated abundance of the 1987 subcatchables (as of August 1987) was 18,589 (SE = 786). This represents a survival to late August of 55% (SE = 2.3%) of the 34,039 fish stocked in May 1987. The estimated abundance of older rainbow trout was 7,967 (SE = 765).

During the first sampling period (18-20 August), sampled rainbow trout (n = 1,167) ranged in length from 120 to 335 mm (Table 4). Mean length was 175 mm. During the second sampling event (16-20 September), sampled rainbow trout (n = 2,563) ranged in length from 122 to 550 mm. Of these, 258 were recaptures. Mean length of recaptured fish was 189 mm (SE = 1.6) which is 14 mm longer than that of fish from the first sampling event. Length bias between the first and second sampling events was evaluated with a Kolomogorov-Smirnov two sample test. The length distributions of the two samples were significantly different (D.N. = 0.30; p = 0.01). However, plots of the length frequencies of the two samples (Figure 2) indicate that these differences are due to an average growth of about 20 mm by rainbow trout between the two sampling events. Therefore, stratification by size group was not necessary. By September 1987, 55% of the trout in the lake were longer than 180 mm, which is considered a minimum catchable size for rainbow trout (Doxey 1980).

Birch Lake Coho Salmon:

Sampling of coho salmon was performed in conjunction with mark-recapture sampling of rainbow trout. Coho salmon ranged in length from about 80 to 380 mm (Figure 3). Attempts to estimate the abundance of coho salmon were unsuccessful due to low capture rates. One hundred forty-seven age 0 and seven older coho salmon were captured during the August sampling period. During recapture efforts in late September, 273 age 0 and 78 older fish were captured. Only three age 0 and four older coho salmon were recaptured.

Coho salmon growth rates from late August to mid-September were similar to those of rainbow trout (Table 5). Age 0 and 1 coho salmon grew an average of 9 mm and 25 mm, respectively. The majority of coho salmon stocked as fingerlings in 1986 had reached catchable size (180 mm) by August 1988.

Quartz Lake Rainbow Trout:

Over 3,300 rainbow trout were sampled from Quartz Lake during the mark-recapture experiment conducted during September and October 1987. As with rainbow trout sampling at Birch Lake, capture probabilities in each half of the lake were significantly different ($\chi^2 = 4.86$, df = 1, $p < 0.05$), and fish marked in each half of the lake did not mix adequately between sampling events ($\chi^2 = 6.96$, df = 2, $p < 0.05$). However, attempts to estimate rainbow trout abundance using methods developed by Darroch (1961) failed because of the

Table 4. Length composition of rainbow trout sampled from Birch Lake, 1987.

| Date | Stocking Cohort | Length Range | Mean Length | Number Sampled | Standard Error |
|---|---|---|---|---|---|
| 8/18/87 - 8/20/87 | Entire Sample | 120-335 mm | 175 mm | 1,167 | 0.8 |
| 9/16/87 - 9/20/87 | Entire Sample | 122-550 mm | 196 mm | 2,563 | 0.6 |
| 9/16/87 - 9/20/87 | 1987 Subcatchable | 165-201 mm[1] | 183 mm[1] | 1,793[1] | 0.2 |
| 9/16/87 - 9/20/87 | 1986 & Older | 194-256 mm[1] | 225 mm[1] | 770[1] | 1.1 |

[1] Estimate was obtained using NORMSEP.

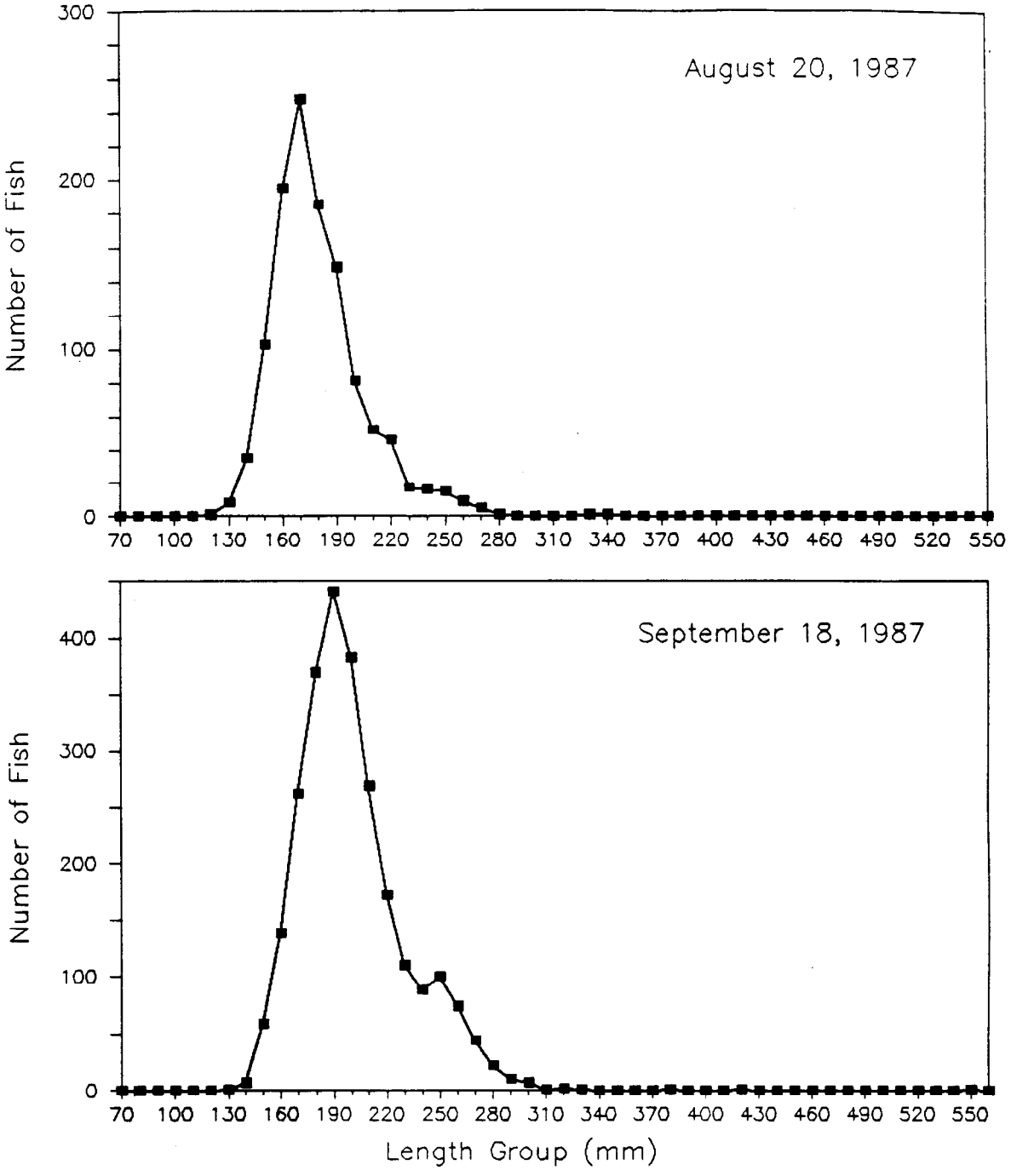


Figure 2. Birch Lake rainbow trout lengths.

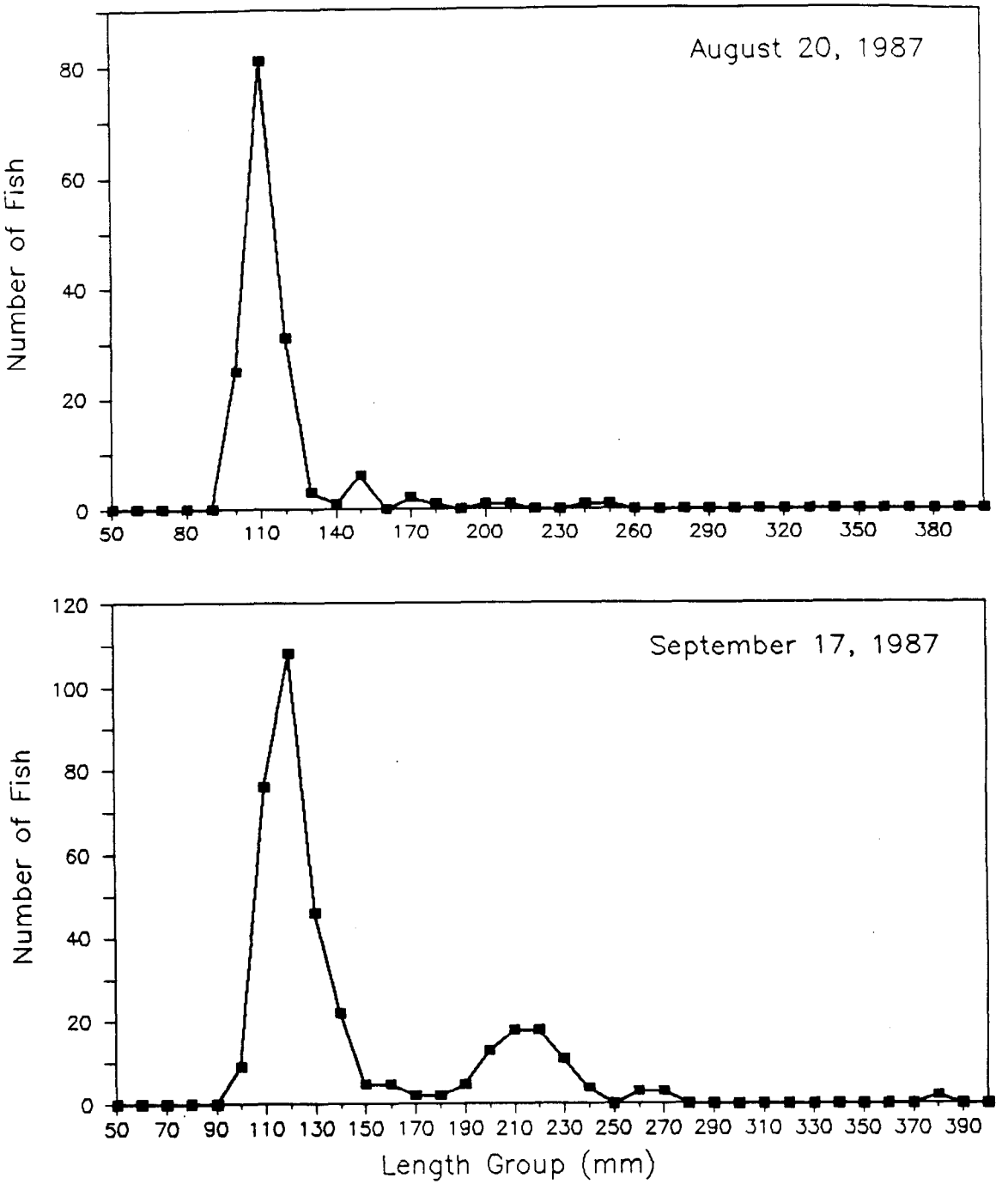


Figure 3. Birch Lake coho salmon lengths.

Table 5. Length composition of coho salmon sampled from Birch Lake, 1987.

| Date | Stocking Cohort | Length Range | Mean Length | Number Sampled | Standard Error |
|---|---|---|---|---|---|
| 8/18/87 - 8/20/87 | 1987 Fingerling | 92-148 mm | 108 mm | 147 | 0.8 |
| 9/15/87 - 9/17/87 | 1987 Fingerling | 96-164 mm | 117 mm | 273 | 0.7 |
| 8/18/87 - 8/20/87 | Age 1 | 169-209 mm | 184 mm | 5 | 6.9 |
| 9/15/87 - 9/20/87 | Age 1 | 177-235 mm | 209 mm | 71 | 1.7 |
| 8/18/87 - 8/20/87 | Age 2 | 235-250 mm | 243 mm | 2 | 7.5 |
| 9/15/87 - 9/20/87 | Age 2 | 252-270 mm | 260 mm | 6 | 3.30 |
| 9/15/87 - 9/20/87 | Age 3 | 378-379 mm | 379 mm | 2 | 0.5 |

presence of negative probabilities of capture. The negative probabilities of capture were attributed to the failure of one trap to fish effectively during the recapture event.

Gear size selectivity was also evaluated. During the first sampling period (23 September), all sampled rainbow trout from the fingerling cohorts (n = 1,433) ranged in length from 119 to 468 mm. Mean length was 213 mm (SE = 1.13). During the second sampling event (5-9 October), sampled fingerling rainbow trout (n = 1,365) ranged in length from 137 to 486 mm. Of these, 291 were recaptures. Mean length of fish in the second sample was 240 mm, which is 27 mm longer than that of fish from the first sampling event. Length bias between the first and second sampling events was evaluated with the chi-square statistic. The length distributions of the two samples were significantly different ($X^2$ = 129.46, df = 3, $p < 0.001$) However, plots of the length frequencies of the two samples (Figure 4) indicate that these differences are due to an average growth of about 27 mm between the two sampling events. Therefore, stratification by size group was not necessary.

Similar results were obtained from samples of rainbow trout stocked as subcatchables. During the first sampling event, mean length was 220 mm (n = 168; SE = 2.64). Length range was 152-310 mm. Mean length of the sample of 282 subcatchables from the second event was 233 mm (SE = 1.70). Length distributions of the two samples were significantly different ($X^2$ = 25.85, df = 2, $p < 0.001$). An average growth of 13 mm between sampling events is the probable cause of this significant difference (Figure 4).

Since length selectivity was not a factor and since it was not possible to perform a stratified abundance estimate (Darroch estimate), an unstratified Petersen estimate was calculated. The estimated abundance of rainbow trout in Quartz Lake during September 1987 was 9,489 (Table 6). This estimate must be considered a minimum due to the sampling bias already discussed. Approximately 15% of the sampled rainbow trout were stocked as subcatchables in May 1987. Therefore the estimated abundance of that cohort in September was 1,419 fish (SE = 91). This represents a survival of 14.2% (SE = 0.9%) for the 10,000 fish stocked in spring 1987.

In early October, subcatchable rainbow trout stocked in 1987 averaged 233 mm (Table 7). The remaining rainbow trout were separated into two distinct cohorts with no overlap in their length distributions. The smaller fish were stocked as fingerlings in 1986 (mean length = 224 mm). The larger fish (stocked prior to 1986) averaged 400 mm (Table 7). By October, 98% of the subcatchables stocked in 1987 and 95% of the fingerlings stocked in 1986 were of catchable size (180 mm).

A total of 33 rainbow trout were sampled for length during the August, 1987 creel census. Length range was 211-445 mm, and a total of 16 (48% of the sample) overlapped the upper 58% of the length range of the subcatchables (Table 7). However, only 2 fish (12.5%) were identified as subcatchables. An expansion of this data indicated that an estimated 36 subcatchables were harvested by sport fishermen during August (total harvest of all cohorts was 592 rainbow trout, SE = 370; Baker in press).

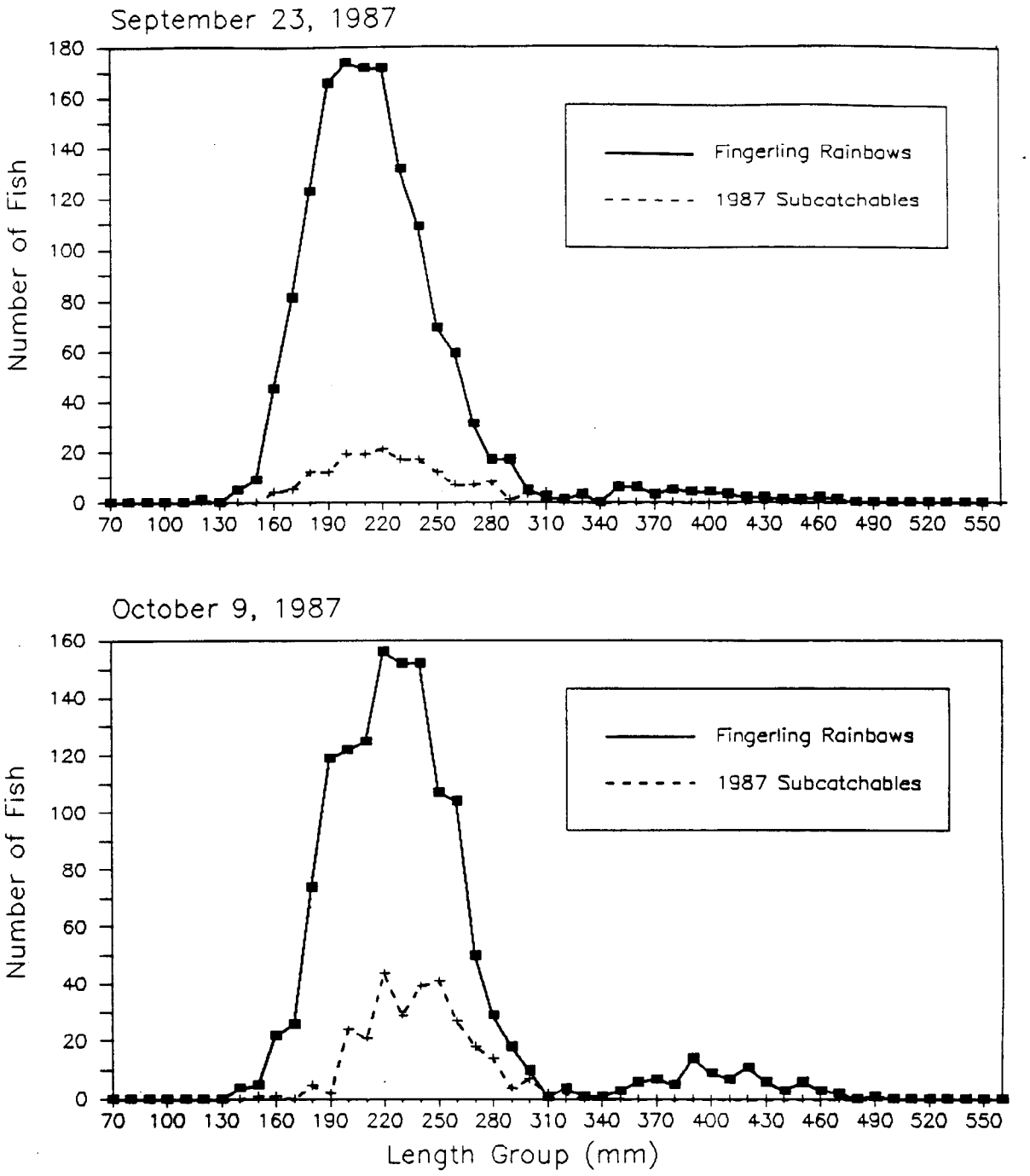


**Figure 4.** Quartz Lake rainbow trout lengths.

Table 6. Numbers of rainbow trout sampled and estimated abundance from the mark-recapture experiment at Quartz Lake, 1987.

| Cohort | Number Marked | Number Examined | Number Recaptured | Estimated Abundance | Standard Error |
|---|---|---|---|---|---|
| All rainbow Trout | 1,595 | 1,747 | 293 | 9,489 | 455 |
| 1987 Subcatchables | (Abundance derived using Equations 5, 6, 7, & 8) | | | 1,419 | 91 |

Table 7. Length composition of rainbow trout sampled from Quartz Lake, 1987.

| Stocking Cohort | Length Range | Mean Length | Number Sampled | Standard Error |
|---|---|---|---|---|
| 1987 Subcatchable[1] | 147-319 mm | 233 mm | 282 | 1.7 |
| Larger,[2] Older fish | 340-486 mm | 400 mm | 84 | 3.5 |
| Smaller[3] fish | 137-328 mm | 224 mm | 991 | 0.9 |

[1] Fish were marked with an adipose finclip before being stocked.
[2] Primarily fish stocked in 1985 or earlier.
[3] Primarily from the 1986 fingerling stocking (late summer).

Quartz Lake Coho Salmon:

An attempt to estimate the abundance of Quartz Lake coho salmon in conjunction with the rainbow trout mark-recapture experiment achieved results similar to those for the Birch Lake coho salmon. Coho salmon ranged from about 70 to 390 mm (Figure 5). Low numbers of fish captured made an estimate impossible.

During sampling in early October, coho salmon that were stocked as 2 to 4 g fingerlings in May averaged 118 mm (Table 8). The 1986 cohort averaged 227 mm while two fish from the 1985 stocking cohort averaged 312 mm.

Other Rainbow Trout Lakes:

During the summer of 1987, estimates of rainbow trout abundance were made at Jan, North Twin, South Twin, and Robertson Number Two Lakes, Bathing Beauty Pond, and 45 Mile Chena Hot Springs Road Pit (Table 9). Overwinter survivals (from time of stocking to June or July of the next year) of identifiable cohorts ranged from 14% at Robertson Number Two Lake to 83% at South Twin Lake. Average survival was 48.6% (SE = 2.9).

The slowest growth rates occurred in Robertson Number Two, Jan, and North Twin Lakes where rainbow trout stocked as fingerlings in 1986 averaged only 111, 120, and 124 mm in length, respectively, during July 1987 (Table 10; Figures 6, 7, and 8). At the same time, rainbow trout fingerling lengths averaged 189 mm at South Twin Lake and in October they averaged 183 mm at Bathing Beauty Pond (Table 10). Fingerlings stocked in 1985 at Robertson Number Two Lake averaged only 196 mm (Figure 6), while at Jan Lake they averaged 256 mm (Figure 8).

Chinook Salmon Lakes:

Mark-recapture estimates of chinook salmon abundance were completed in two lakes during 1987. Chinook salmon ranged in length from about 90 to 300 mm in Little Harding Lake and from about 100 to 230 mm in Bolio Lake (Figure 9). The estimated abundance in Bolio Lake during July was 6,542 chinook salmon (Table 11). Twenty thousand chinook salmon were stocked in June 1986. Therefore, the estimated overwinter survival rate was 32% (SE = 4%). In Little Harding Lake, the estimated abundance of chinook salmon in June was 3,045 (Table 11). Ten thousand chinook salmon were stocked in 1986, giving an overwinter survival rate of 30% (SE = 3.7%).

Age 1 chinook salmon sampled in June were 185 and 198 mm in length in Little Harding and Bolio Lakes, respectively (Table 12). Chinook salmon stocked in Bolio Lake in 1987 grew an average of 20 mm in length between late June and early July. However, fingerlings stocked in 1986 grew little between 24 June 1987 and 6 August 1987 (Table 12). Fingerling chinook salmon stocked in Little Harding Lake prior to 1986 averaged 262 mm.

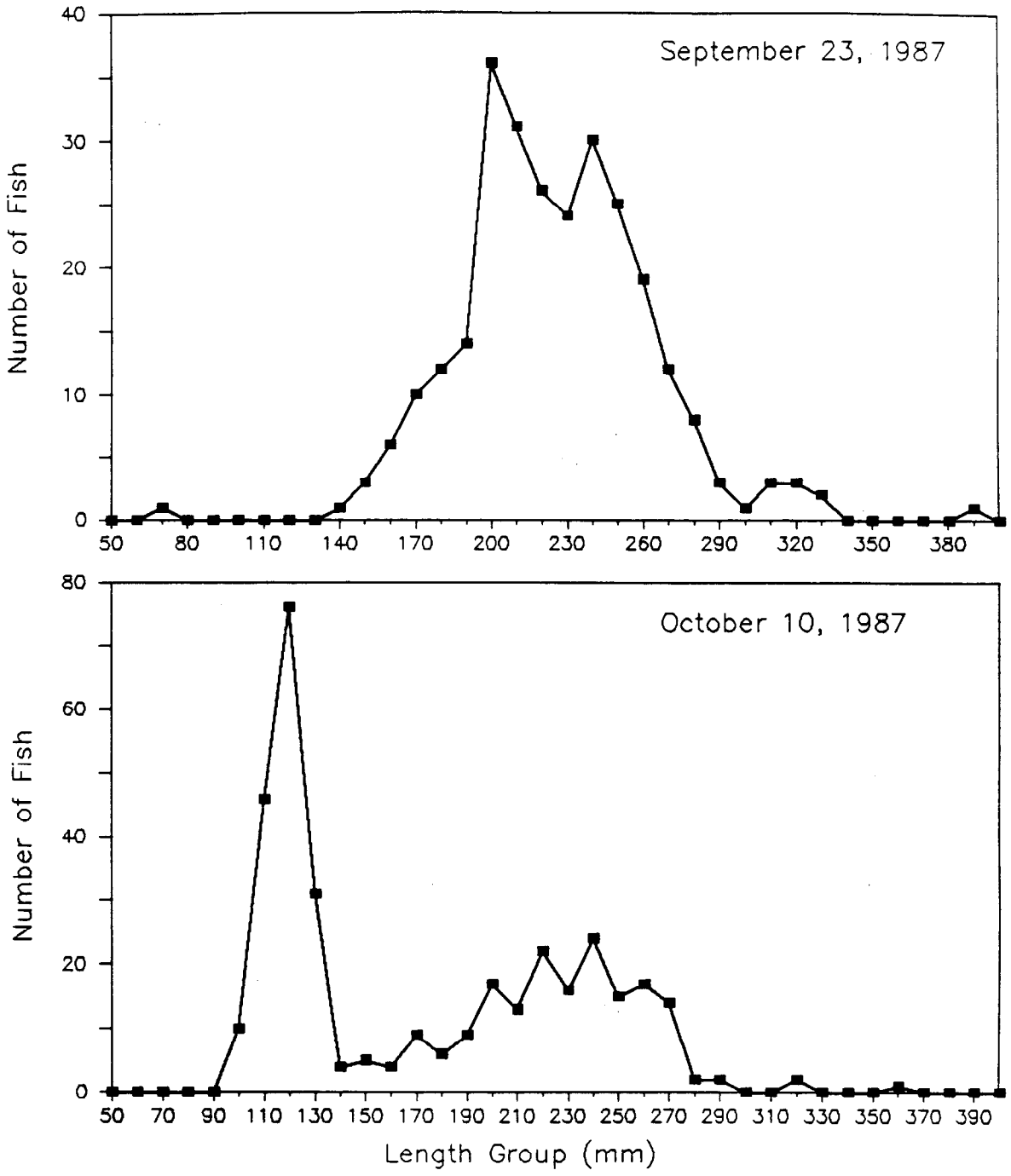


**Figure 5. Quartz Lake coho salmon lengths.**

Table 8. Length composition of coho salmon sampled from Quartz Lake, 1987.

| Stocking Cohort[1] | Length Range | Mean Length | Number Sampled | Standard Error |
|---|---|---|---|---|
| 1987 | 97-169 mm | 118 mm | 185 | 1.1 |
| 1986 | 172-285 mm | 227 mm | 157 | 2.1 |
| 1985 | 311-313 mm | 312 mm | 2 | 1.0 |
| 1984 | - | 358 mm | 1 | - |

[1] All coho salmon were stocked as 2 to 4 g fingerlings in late May or early June.

Table 9. Numbers of rainbow trout sampled and estimated abundance from mark-recapture experiments on smaller lakes, 1987.

| Location | Date | Date Stocked[1] | Number Marked | Number Examined | Recaps | Population Estimate | Standard Error | Percent Survival[2] | Standard Error |
|---|---|---|---|---|---|---|---|---|---|
| Bathing Beauty Pond | 6/87 | 1986 | 210 | 79 | 31 | 527 | 65.51 | 53.00 | 6.5 |
| 45.5 Mi C.H.S.R. | 6/87 | 1986 | 342 | 170 | 106 | 547 | 26.77 | 55.00 | 2.7 |
| Jan Lake | 7/87 | 1985 & 1986 | 677 | 356 | 53 | 4,655 | 544.00 | - | |
| | | 1985 | | | | 698[3] | 99.00 | 8.00 | 1.0 |
| | | 1986 | | | | 3,957[3] | 466.00 | 45.00 | 1.7 |
| North Twin Lake | 7/87 | 1986 | 565 | 246 | 83 | 1,664 | 135.00 | 42.00 | 1.0 |
| South Twin Lake | 7/87 | 1986 | 706 | 309 | 65 | 3,320 | 343.00 | 83.00 | 2.7 |
| Robertson #2 | 7/87 | 1983, 1985, 1986 | 182 | 298 | 79 | 684 | 49.00 | - | |
| | | 1986 | | | | 417[3] | 42.00 | 14.00 | 0.4 |
| | | 1985 | | | | 256[3] | 34.00 | 12.00 | 1.7 |
| | | 1983 | | | | 11[3] | 0.56 | 0.76 | 0.00 |

1 All fish were stocked as fingerlings.

2 Percent survivals are calculated population estimates divided by the number of fish originally stocked.

3 Proportional formulas applied to total estimate.

Table 10. Length composition of rainbow trout sampled during mark-recapture experiments during 1987.

| Location | Date | Stocking Cohort | Number Sampled | Length Range | Mean Length | Standard Error |
|---|---|---|---|---|---|---|
| Jan Lake | 7/07/88 | 1986 Fingerlings | 203 | 95-159 mm | 120 mm | 1.2 |
| " | 7/07/88 | 1985 Fingerlings | 15 | 208-329 mm | 256 mm | 9.6 |
| " | 8/04/87 | 1986 Fingerlings | 739 | 112-207 mm | 153 mm | 0.6 |
| " | 8/04/87 | 1985 Fingerlings | 126 | 214-370 mm | 271 mm | 2.7 |
| South Twin Lake | 6/24/87 | 1986 Fingerlings | 860 | 109-216 mm | 170 mm | 0.7 |
| " | 7/10/87 | " | 126 | 129-232 mm | 189 mm | 1.8 |
| North Twin Lake | 6/24/87 | 1986 Fingerlings | 565 | 73-221 mm | 129 mm | 1.0 |
| " | 7/14/87 | " | 246 | 77-204 mm | 124 mm | 1.5 |
| Bathing Beauty Pond | 10/19/87 | 1986 Fingerlings | 78 | 131-226 mm | 183 mm | 2.0 |
| Robertson Lake #2 | 7/07/87 | 1986 Fingerlings | 78 | 87-136 mm | 111 mm | 1.2 |
| " | " | 1985 Fingerling | 48 | 152-250 mm | 196 mm | 3.7 |
| " | " | 1983 Fingerling | 2 | 371-383 mm | 377 mm | 6.0 |
| " | 8/06/87 | 1986 Fingerling | 210 | 102-164 mm | 129 mm | 0.9 |
| " | " | 1985 Fingerling | 317 | 167-276 mm | 212 mm | 1.2 |
| " | " | 1983 Fingerling | 2 | 360-382 mm | 371 mm | 11.0 |
| Forty Five Mile Pit | 6/12/87 | 1986 Fingerling | 342 | 60-110 mm | 88 mm | 0.5 |
| " | 8/07/87 | " | 170 | 97-194 mm | 137 mm | 1.1 |
| " | 8/25/87 | " | 151 | 102-202 mm | 149 mm | 1.3 |

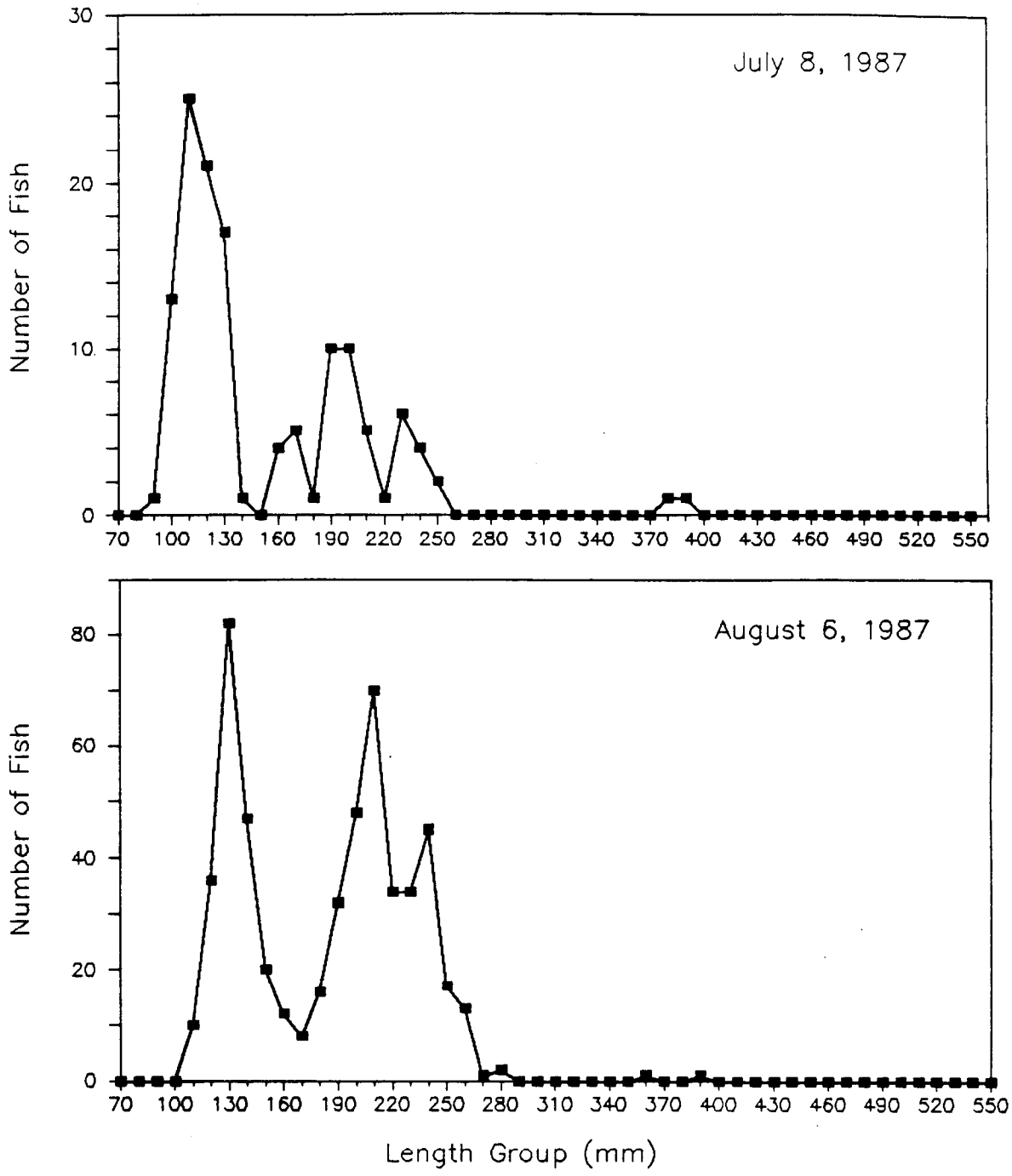


**Figure 6.** Robertson Lake rainbow trout lengths.

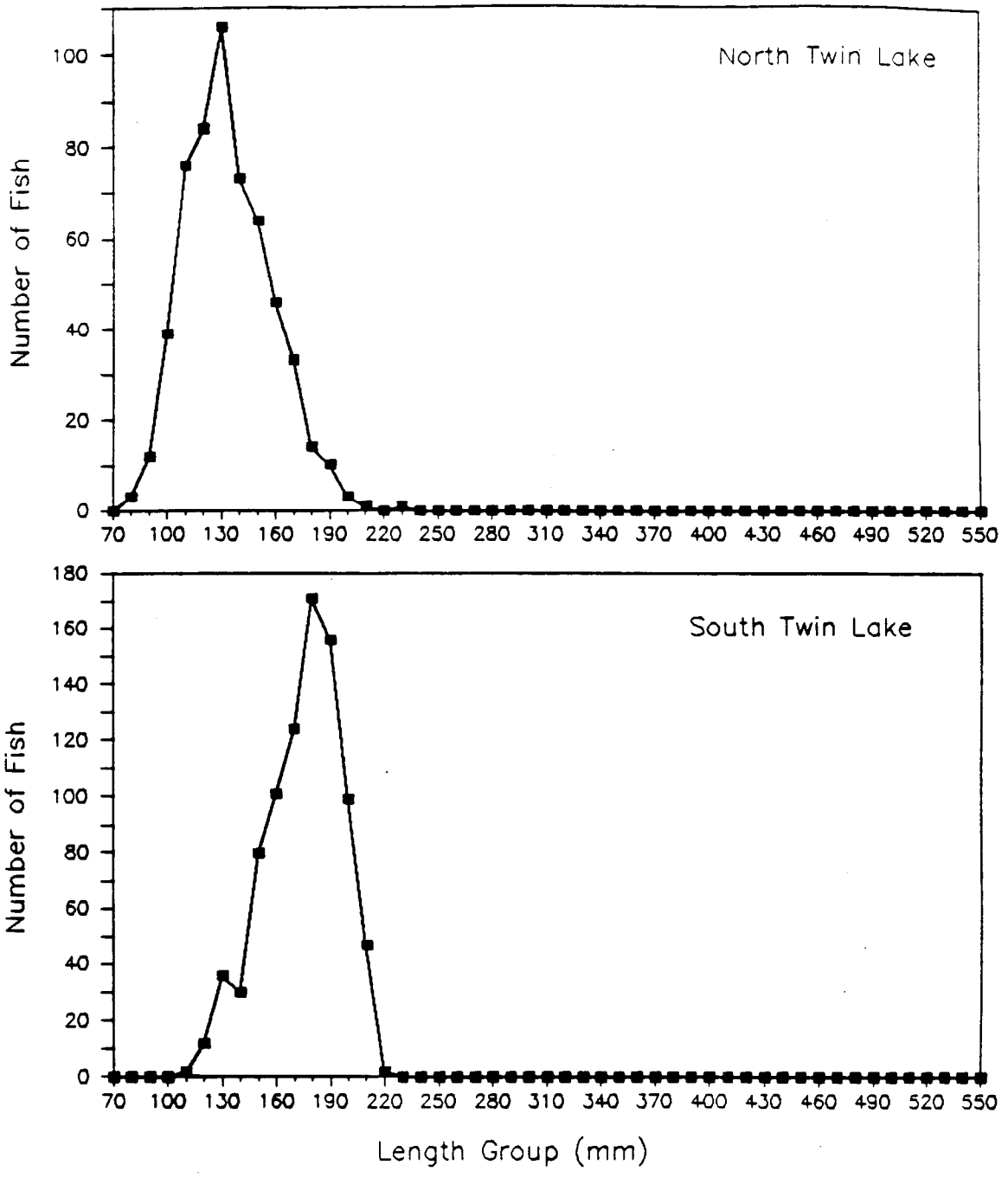


**Figure 7.** North and South Twin Lakes rainbow trout lengths.

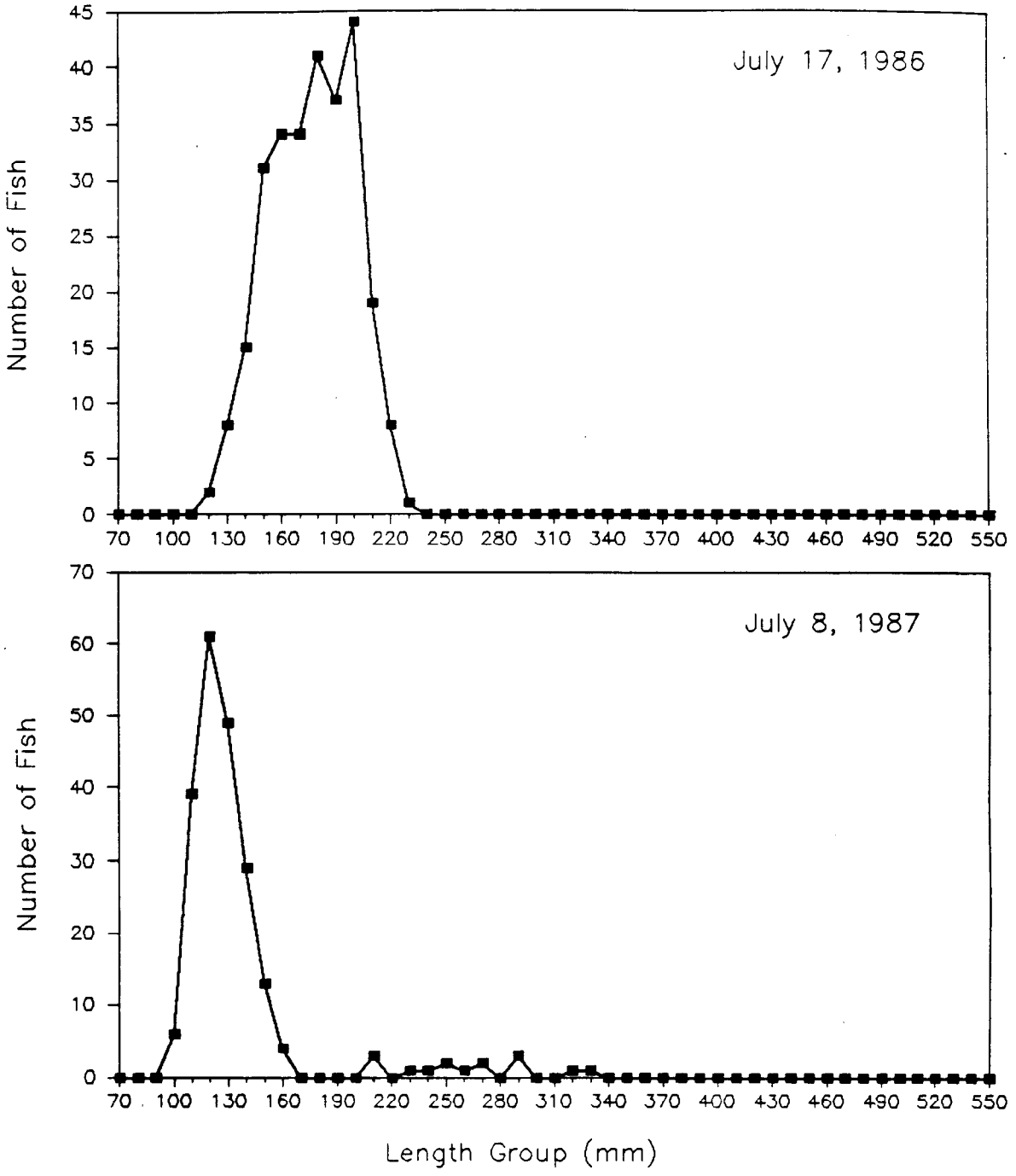


**Figure 8.** Jan Lake rainbow trout lengths.

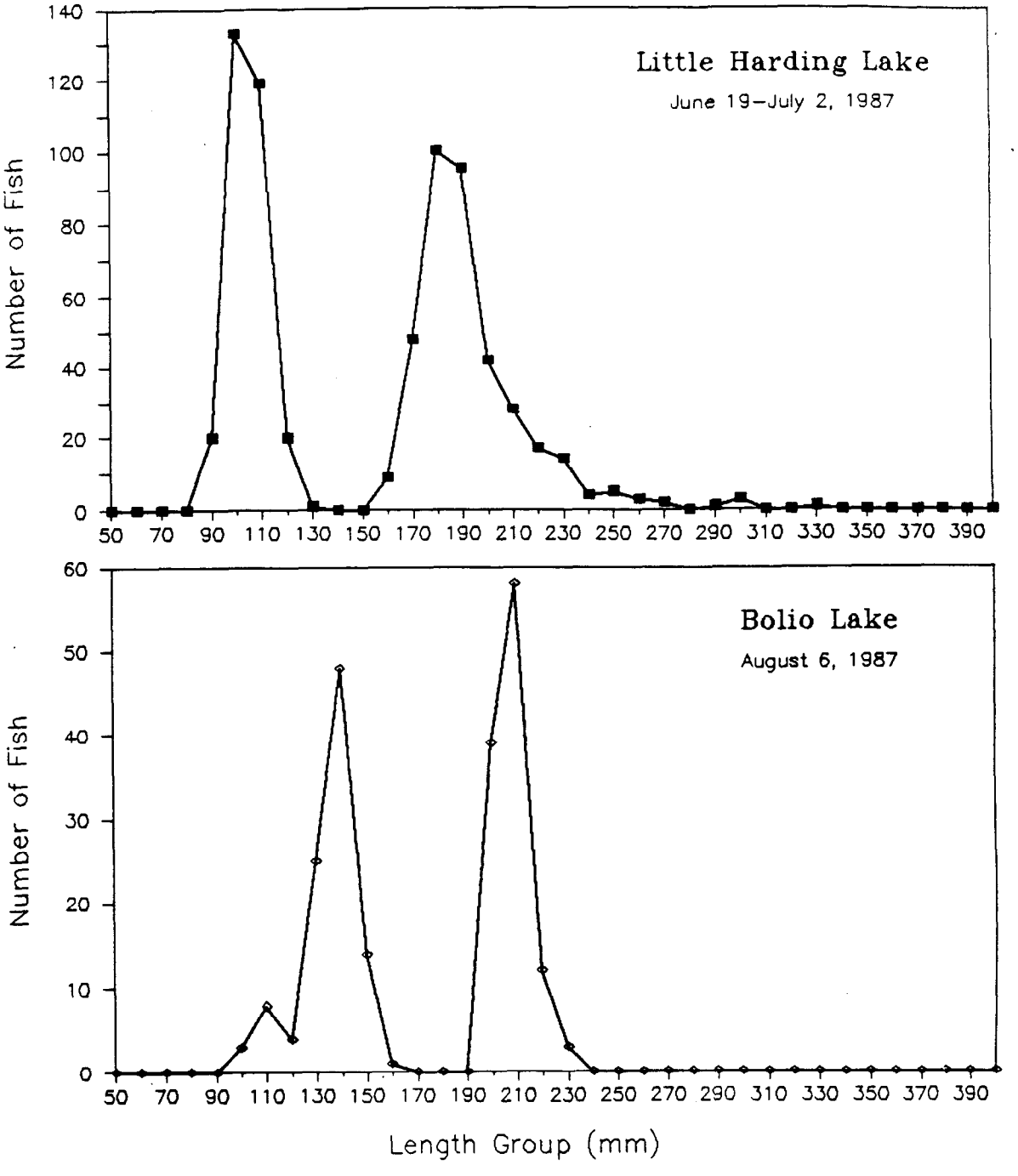


Figure 9. Little Harding Lake and Bolio Lake chinook salmon lengths.

Table 11. Chinook salmon population estimates, 1987.

| Location | Date | Date Stocked[1] | Number Marked | Number Examined | Recaps | Population Estimate | Standard Error | Percent Survival[2] | Standard Error |
|---|---|---|---|---|---|---|---|---|---|
| Bolio Lake | 7/87 | 1986 | 511 | 689 | 53 | 6,542 | 801 | 32 | 4.0 |
| Little Harding | 6/87 | 1986 | 374 | 405 | 49 | 3,045 | 372 | 30 | 3.7 |

[1] All fish were stocked as fingerlings.

[2] Percent survivals are calculated population estimates divided by the number of fish originally stocked.

Table 12. Length composition of chinook salmon sampled from Little Harding and Bolio Lakes, 1987.

| Location | Date | Stocking Cohort | Number Sampled | Length Range (mm) | Mean Length (mm) | Standard Error |
|---|---|---|---|---|---|---|
| Little Harding L. | 6/19/87 | 1987 Fingerling | 293 | 82-127 | 100 | 0.4 |
| " | " | 1986 Fingerling | 354 | 154-231 | 185 | 0.9 |
| " | " | 1985 & Older Fingerling | 18 | 238-323 | 262 | 6.2 |
| Bolio Lake | 6/24/87 | 1986 Fingerling | 100 | 174-208 | 198 | 0.6 |
| " | " | 1987 Fingerling | 24 | 91-123 | 110 | 1.5 |
| " | 7/09/87 | 1986 Fingerling | 81 | 190-233 | 200 | 0.6 |
| " | " | 1987 Fingerling | 103 | 99-152 | 130 | 1.1 |
| " | 8/06/87 | 1986 | | | | |
| " | " | Fingerling | 112 | 192-226 | 203 | 0.6 |

Test Netting

Harding Lake:

During the open water period of 1987, Harding Lake was sampled for a total of 47 net nights with fyke nets and 146 net nights with vertical and sinking gill nets. A total of 2,541 fish were captured: 2,293 least cisco; 152 northern pike, 24 burbot, 25 lake trout, 35 sheefish, 11 rainbow trout, and one Arctic grayling.

Monthly distributions of captured fish by depth are presented in Table 13. Gill nets were generally not set in water shallower than 5 m or along aquatic vegetation and other northern pike habitat because of the probability of injuring or killing northern pike in these areas. Distributions of indigenous species in the lake were generally consistent with previous observations (Doxey 1982, 1983, 1984). Vertical gill nets were ineffective at capturing large numbers of fish (71 fish total in 84 net nights). Least cisco were observed near the surface over deep water throughout the summer. However, few least cisco were caught near the surface in vertical gill nets, indicating avoidance of the vertical gill nets by least cisco. Two northern pike were caught 7 m below the surface in water 30 m deep, indicating some use of the upper levels of the lake away from the littoral area by that species.

Lake trout weights ranged from 340 to 11,000 g (weights were estimated as live fish were released without removing them from the water). Sixteen lake trout weighed less than 5,400 g and were considered products of natural reproduction in Harding Lake. Five more fish weighing between 5,400 and 6,800 g could either have been stocked or spawned in the lake. Four fish in the 9,000 to 11,000 g range were stocked as adults in the late 1960's.

Thirty-five sheefish, representing two stocking cohorts, both stocked in 1987, were captured (Table 14). Three out of 35 excess brood stock sheefish (identified by floy tags) were captured and released. Two of these were caught in vertical gill nets at depths of 1 and 2 m, respectively, in water 30 m deep. The third was caught near the bottom in 30 m of water. The remaining 32 sheefish captured were stocked as fingerlings in 1987. Twenty-two were caught in late May, a few days after stocking. Five of these were caught in a gill net set at 30 m (the same set that took the big fish mentioned above). The rest were caught in small numbers in fyke nets. The last sheefish was captured in late July. It was 75 mm long and in poor condition. The presence of northern pike in almost all fyke nets made it difficult to document the presence of stocked fingerling sheefish since any small fish caught in the nets were likely eaten by the northern pike (Doxey 1985).

Eleven rainbow trout, representing two stocking cohorts, were sampled in early July. A single 102 mm rainbow trout from the 1986 rainbow trout fingerling cohort was removed from the gut of a northern pike that had been swallowed by another northern pike. The remaining 10 rainbow trout were stocked as fry in June 1987, and were found gilled in a fyke net set near the release point. Average length was 50 mm (Table 14).

Table 13. Harding Lake fish distribution by depth. All data are from gillnet and fyke net samples obtained during 1987.

| Depth Zones | Species[1] present at depth during time periods: 5/24 - 5/30 | 6/30 - 7/03 | 7/28 - 7/31 | 8/18 - 8/20 | 9/29 - 10/02 | 10/12 - 10/27 | Total effort at depth, Net Nights |
|---|---|---|---|---|---|---|---|
| Nearshore - Bank to 1.3 m (Fyke nets) | NP SF | NP SF | NP SF | LCI NP BB | Not Fished | LCI NP RT | 47 |
| Offshore | | | | | | | |
| 0 - 3 m | Not Fished | SF | SF | SF | LCI | Not Fished | 13 |
| 3 - 13 m | Not Fished | LT LCI | NP,LT BB LCI | NP LCI LT | NP,LT BB LCI | Not Fished | 28 |
| 13 - 23 m | Not Fished | LCI BB | BB LT LCI | LCI LT | BB LT LCI | Not Fished | 30 |
| 23 - 31 m | Not Fished | LCI | BB LCI | BB LT LCI | BB LT LCI | Not Fished | 29 |
| 30 - 42 m | Not Fished | LCI SF | LCI BB | LCI BB | LCI LT | Not Fished | 9 |
| 42 - 47 m | Not Fished | No Fish Captured | Not Fished | Not Fished | Not Fished | Not Fished | 1 |

[1] NP = northern pike, SF = sheefish, BB = burbot, LT = lake trout, LCI = least cisco, RT = rainbow trout

Table 14. Size data for Harding Lake fish sampled in 1987.

| Species | Number Sampled | Length Range | Weight Range |
|---|---|---|---|
| Lake Trout | 25 | ----- | 340 - 11,000 g[1] |
| Northern Pike | 119 | 83 - 690 mm | ----- |
| Least Cisco | 2,293 | 90 - 260 mm[2] | ----- |
| Burbot | 24 | 75 - 740 mm | ----- |
| Grayling | 1 | 90 mm | ----- |
| Rainbow Trout | 1 | 102 mm | ----- |
| " | 10 | ™50 mm | ----- |
| Sheefish | 32 | 75 - 110 mm | ----- |
| " | 3 | ----- | 900 - 1,800 g[1] |

[1] Estimated weights.
[2] Estimated lengths.

A single grayling, 90 mm long, was caught in a fyke net on 20 August. It was stocked either in the fall of 1986 as a fingerling or in the spring of 1987 as a sac-fry.

Small Stocked Lakes:

Length data for miscellaneous stocked species collected during the summer is presented in Table 15. A total of six Arctic char sampled from Trap Lake averaged 138 mm. The fish are survivors from the first group of Arctic char stocked in Region III. Examination of the gut contents of these fish revealed a variety of food items, ranging from zooplankton to small fish. The prey fish were either sculpin *Cottus cognatus* or blackfish *Dalia pectoralis*. Their digested condition precluded further identification.

The mean length of ten coho salmon sampled from Dune Lake was 256 mm. This represented excellent growth for fish that had been stocked as fingerlings only 10 months before. No coho salmon were taken during gillnet sampling of Thirty-one Mile Pit. A sample of five coho salmon from Twenty-eight Mile Pit had a mean length of 227 mm. The gillnet at Johnson Road Pit Number One was vandalized and hidden, but upon recovery a total of seven coho salmon were measured. Mean length of these fish stocked as fingerlings in 1986 was 162 mm. Samples of coho salmon from the 1986 (n = 9) and 1985 (n = 11) stocking cohorts netted in Manchu Lake averaged 161 mm and 253 mm in length, respectively.

Hidden Lake, a gravel pit on Eielson AFB, was sampled with fyke nets in summer 1987. Large numbers of lake chubs *Couesius plumbeus* and longnose suckers *Catostomus catostomus* were captured. No stocked Arctic grayling or rainbow trout were found. No rainbow trout were captured during test gillnetting of Johnson Road Pit Number 1 or Thirty-one Mile Pit. Rainbow trout captured in a gillnet in Manchu Lake had an average length of 117 mm (n = 71).

Small numbers of sheefish were taken during test gillnetting in Ghost Lake, Silver Fox Pit, and Weigh Station Ponds One and Two. Lengths ranged from 100 mm for younger fish to 575 mm for an age 3 or 4 specimen from Silver Fox Pit.

Piledriver Slough Rainbow Trout:

Piledriver Slough was stocked with three sizes of rainbow trout during 1987 (Appendix Table 1). Trout stocked in May 1987 as catchables began entering the sport fishery immediately (Tim Baker 1988). By late summer, larger rainbow trout had reportedly spread throughout the system, with harvests reported downstream from the stocking areas (between the confluence of Moose Creek with Piledriver Slough and the Tanana River) and in the Moose Creek system east of the Richardson Highway. In October, staff observed rainbow trout fingerlings (along with Arctic grayling fingerlings and slimy sculpins) trapped in a discontinuous pool under the ice in the upper part of the system. While these fish undoubtedly died during the winter, their presence indicates that rainbow trout also spread into the upper system. The area where they were found was about 13 km upstream from the furthest point at which stocking occurred.

Table 15. Sampling effort and size structure of fish sampled in other Region III stocked lakes, 1987.

| Location | Date | Species[1] & Stocking Cohort (If Known) | Number Sampled | Length Range | Mean Length | Standard Error | Gear | Days Fished |
|---|---|---|---|---|---|---|---|---|
| Bolio Lake | 6/24/87 | GR 1983 & 84 Fry | 100 | 199-246 mm | 247 mm | 2.00 | Fyke Net | 1.0 |
| Lost Lake | 7/21/87 | SS 1986 Fingerling | 13 | 147-167 mm | 160 mm | 2.00 | Gill Net | 1.0 |
| | | SS 1985 Fingerling | 1 | --- | 193 mm | | | |
| South Twin Lake | 6/25/87 | KS 1985 Smolt | 7 | 396-437 mm | 414 mm | 6.00 | Fyke Net | 1.0 |
| | 8/6/87 | | 7 | 406-424 mm | 413 mm | 4.00 | Fyke Net | 1.0 |
| Geskakmina Lake | 4/30/87 | SS 1986 Fingerling | 20 | 180-217 mm | 196 mm | 2.00 | Hook & Line | 1.0 |
| Dune Lake | 4/30/87 | GR 1983 & 84 Fry | 10 | 309-378 mm | 339 mm | 8.00 | Hook & Line | 1.0 |
| | | SS 1986 Fingerling | 10 | 240-286 mm | 256 mm | 4.00 | Hook & Line | 1.0 |
| Manchu Lake | 6/10/87 | SS 1986 Fingerling | 9 | 149-187 mm | 161 mm | 4.00 | Gill Net | 1.0 |
| | | SS 1985 Fingerling | 11 | 223-282 mm | 253 mm | 5.00 | Gill Net | 1.0 |
| | | RT 1986 Fingerling | 71 | 99-133 mm | 117 mm | 1.00 | Gill Net | 1.0 |

- Continued -

Table 15. Sampling effort and size structure of fish sampled in other Region III stocked lakes, 1987 (Continued).

| Location | Date | Species[1] & Stocking Cohort (If Known) | Number Sampled | Length Range | Mean Length | Standard Error | Gear | Days Fished |
|---|---|---|---|---|---|---|---|---|
| Ghost Lake | 8/15/86 | SF 1981 Fingerling | 12 | 196-262 mm | | | Gill Net | 1.0 |
| | | | 1 | 425 mm | | | Gill Net | 1.0 |
| Trap Lake | 8/13/87 | AC 1986 Fingerling | 6 | 126-148 mm | 138 mm | 2.64 | Gill Net | 4.0 |
| 28 Mi Pit | 6/09/87 | SS | 5 | 205-257 mm | 227 mm | 8.80 | Gill Net | 1.0 |
| Johnson Road #1 | 7/23/87 | SS 1986 Fingerling | 7 | 132-171 mm | 162 mm | 7.40 | Gill Net | 0.5 |
| 31 Mile Pit | 7/23/87 | LNS | 20 | - | - | - | Gill Net | 1.0 |
| | | LC | 35 | - | - | - | Gill Net | 1.0 |
| Silver Fox Pit | 7/21/87 | SF 1984-1986 Fingerling | 9 | 120-575 | 215 mm | 46.80 | Gill Net | 1.0 |
| Weigh Station #1 | 7/21/87 | SF | 4 | 110-200 | 155 mm | 22.50 | Gill Net | 1.0 |
| | | LNS | 12 | - | - | - | | |
| Weigh Station #2 | 7/21/87 | SF | 11 | 100-180 | 122 mm | 10.70 | Gill Net | 1.0 |
| | | LC | 12 | - | - | - | | |
| Hidden Lake | 6/15/88 | LC | Large | - | - | - | Fyke Net | 2.0 |
| | | LNS | Numbers | - | - | - | | |

[1] GR = Arctic grayling, SS = coho salmon, KS = chinook salmon, RT = rainbow trout, SF = sheefish, AC = Arctic char, LNS = longnose sucker, LC = lake chub

Winter sampling in two areas of Piledriver Slough indicated that sufficient dissolved oxygen was present to sustain fish life. The dissolved oxygen level at the Bailey Bridge site was 5.5 ppm. At the Eielson Farm Road culverts, the dissolved oxygen level was 3.5 ppm. Both measurements were taken on 13 January 1988.

The water level of Piledriver Slough fluctuates according to the stage of the adjacent Tanana River, which feeds groundwater to Piledriver Slough. The Tanana was extremely low during the winter of 1987-88, so water levels in Piledriver Slough were probably abnormally low. The winter weather was unusually mild, and heavy aufeis buildup that usually occurs on some parts of the slough was not present in spring, 1988.

Staff observations and angler catch returns in April and May 1988 indicate that large rainbow trout stocked in 1987 either overwintered in, or returned to, Piledriver Slough. A single rainbow trout was seen in an ice-free pool by Department personnel in mid-April. As breakup proceeded in late April and early May, anglers reported catching rainbow trout along with Arctic grayling. One angler reported catching (and releasing) rainbow trout at the ratio of about ten rainbow trout to 120 Arctic grayling.

## DISCUSSION

Three of the five assumptions (as outlined in the methods) necessary for the accurate use of a Petersen abundance estimator were met during all mark-recapture experiments. These were:

1. no immigration or emigration is possible in a landlocked lake;

2. the fish do not lose their mark because the caudal finclip is recognizable even if considerable fin regeneration has occurred; and,

3. each fish taken during the recapture sample is examined for a finclip by the project leader or his assistant, and therefore, it is reasonable to assume that all finclips were noted.

Two assumptions were more difficult to meet. First, the degree to which marking affects the probability of capture in the recapture event has never been assessed in these lakes. Second, the assumption of random mixing, or random sampling in either the marking or recapture event was violated at both Birch and Quartz Lakes (the only lakes at which we tested this assumption). Thus, the stratified Darroch estimator was used for Birch Lake data. At Birch Lake, use of this estimator resulted in a 56% increase in estimated abundance over that given by the Petersen estimator. Unfortunately, the Darroch estimator could not be used with the Quartz Lake data due to negative probabilities of capture resulting from the failure of one trap to fish effectively during the recapture event. Thus the abundance estimate (and resulting low survival rate) for the subcatchable rainbow trout stocked in Quartz Lake is suspect and must be considered a minimum. One method of avoiding such bias in future estimates is the use of more traps so that more of the lake shoreline will be sampled. This will have two benefits: 1) it will spread the sampling over a

larger area and possibly result in a more uniform mark throughout the lake; and 2) failure of one trap to fish effectively will have a less dramatic effect on capture probabilities.

Survival of rainbow trout stocked in Birch Lake as subcatchables has ranged from 54.7% (Doxey 1981) to 67% (Doxey 1987). The 1987 survival estimate (55%) using the Darroch estimate is within this range. Future research will determine whether 14% is a representative survival figure for subcatchables stocked into Quartz Lake. A low proportion of subcatchables were sampled in the creel during August, 1987 (Baker in press), even though size of subcatchables (mean = 233 mm, maximum = 319 mm) was acceptable to anglers. This supports the accuracy of the low survival estimate, and indicates that low survival is not due to angler harvest. However, because statistical analysis indicates that the estimate is probably biased low, because Birch and Quartz Lakes are similar in size and species composition, and because conditions can change from one year to the next, it is feasible that future survival estimates will be in the range of those noted at Birch Lake. In any case, even this minimum estimate is substantially above the rate of return to the fishery of less than 5% obtained from past stocking of fingerling rainbow trout at Quartz Lake, and therefore, the subcatchable stockings warrant future evaluation.

Fish condition at time of stocking was less than ideal. All of the 1987 subcatchables captured during the population estimates had one or more ventral fins missing and a high proportion had caudal fins with a deformed, "shredded" appearance. These injuries occurred in the hatchery, and many of the fins were damaged to the extent that they could not be regenerated. This phenomenon had been previously noted in a cohort of large rainbow trout stocked into Birch Lake in 1983 (Doxey 1984). Hatchery personnel indicate that the caudal fin condition is a result of a short-term fungal infection in the early life of the fish that is more prevalent during some years than others (Dave Parks, Hatchery Manager; pers. comm.). The missing ventral fins are a result of the trout becoming stressed and biting each other as growth causes increasingly crowded conditions in hatchery raceways.

Stocking fish at an earlier date to reduce raceway loading may be a solution, but in interior Alaska such stocking must be done through the ice in mid-to-late winter. Little is known about the survival of large trout planted under such circumstances. Lake productivity is at a low point at this time and food may be scarce, but the cold water (1 - 4 degrees C) would probably lower metabolic rates, reducing the need for food. Additionally, the largest, best conditioned fish in the raceway would be stocked. The large, well-fed fish could probably survive with minimal food for a longer time in cold water. Additionally, the dissolved oxygen levels in Birch Lake during the winter (7 to 10 ppm; Doxey 1983) are at, or above, levels found in hatchery raceways and fish transport trucks (7 to 9 ppm; Tim Burke, pers. comm.). A small-scale experiment to evaluate stocking of rainbow trout under the ice will be conducted in 1988.

A single 463 mm, age 5, male northern pike was captured in Birch Lake during sampling in September. It was killed immediately. Examination of the growth pattern on his scales indicated that it had been stocked into the lake in June 1987, and had probably spawned before he was stocked. The presence of an

illegally stocked northern pike in Birch Lake presents a potential threat to the sport fishery, especially if others are present and successful spawning occurs.

Rainbow trout growth and survival rate sampling at North and South Twin Lakes present interesting, but expected, results. These two lakes are immediately adjacent to each other, share the same watershed, are the same size, and were stocked in 1986 with trout fingerlings at 200/acre out of the same truck on the same day. North Twin is a deeper lake with the steep shoreline, transparent green water, and rocky bottom normally associated with a mountain lake. However, South Twin Lake is a dark-stained, shallower lake with more detritus on the bottom and patches of lily pads, characteristics of a lowland lake in interior Alaska. Fish populations in both lakes were so low prior to the 1986 rainbow trout stocking that the systems were almost barren (Doxey 1987). South Twin Lake appeared to be more productive than North Twin Lake, and this appearance was born out by the higher overwinter survival (83% vs. 42%) and the larger size at age of rainbow trout (Table 10 and Figure 7). Furthermore, it appears that during the time between sampling periods the rainbow trout in North Twin didn't grow, while those in South Twin grew 19 mm.

Fingerling rainbow trout were stocked into Jan Lake in 1985. This lake had not contained fish for at least 2 years, having been last stocked with coho salmon in 1979. Mean length of fish from the 1985 cohort sampled in July 1986 was 173 mm (length range 119-225 mm). This represents excellent growth for a group of fingerlings in their first summer in a lake (Doxey 1987; Figure 8). Mean length of the fingerlings stocked in 1986 and sampled during July 1987 was 120 mm (length range 95-159 mm). This represents a substantial reduction in growth rate (Table 10 and Figure 8). Survival of that second cohort, however, at 45%, is about average for rainbow trout in small lakes (Table 9).

Robertson Lake Number Two produced, by far, the poorest growth and survival rate of rainbow fingerlings stocked in 1986. Growth of rainbow trout stocked as fingerlings in 1985 was also poor (Tables 9 and 10). This indicates low lake productivity, and suggests that the stocking density of fingerlings at 200 fish/acre/year is excessive. Robertson Lake Number Two has very dark-stained water and a low percentage of littoral area.

Stocking of rainbow trout in Piledriver Slough (the first time rainbow trout were stocked in a stream in interior Alaska) generated considerable public enthusiasm. Creel census angler interviews indicated that fishing was good. However, data gathered was minimal considering the potential value of this new fishery, the possible impact upon other fisheries and fish stocks in the region, and the public controversy that could arise concerning the introduction of non-indigenous fish species into an open system. Sampling efforts should be stepped up in future years.

Chinook salmon at age 1 in Little Harding Lake are longer than were age 1 coho salmon sampled there in the early 1980's. Mean lengths of age 1 coho salmon sampled during June 1980, 1982, 1983, 1984, and 1985 ranged from 130 mm to 146 mm (Doxey 1981, 1983, 1984 and Unpub.). Age 1 chinook salmon sampled in July 1986 were 176 mm ($n = 42$, $SE = 8.4$ mm) and in June of 1987 were 185 mm (Table 12). This larger size may be partially the result of chinook salmon

being stocked at a larger size than coho salmon (9 g versus 4 g). In Bolio Lake, chinook salmon stocked in 1986 grew little from 24 June 1987 to 6 August 1987 (Table 12). Anglers report high catch rates for chinook salmon and their sport fishing potential appears to be excellent. However, the greatest advantage of chinook salmon stockings will occur if they live longer and grow to larger sizes than coho salmon. This remains to be determined.

## RECOMMENDATIONS

1. The stocking level of subcatchable rainbow trout into Quartz Lake should be increased to 50,000.

2. Evaluation of winter stocking techniques for subcatchable rainbow trout should be implemented.

3. Experimental stocking of Arctic char with evaluation should be expanded as more fish become available.

4. Experimental stocking of lake trout with evaluation should begin as fish become available.

5. Study of rainbow trout survival should continue at Birch and Quartz Lakes. Possible sampling changes may include a longer period between the mark and recapture efforts and use of more gear.

6. Study of chinook salmon survival at Bolio, Donnelly, and Little Harding Lakes should be continued.

7. Evaluation to assess the performance of Arctic char stocked into the Coal Mine Road Lakes in 1987 should begin.

8. Multi-species stocking to create mixed species fisheries should be evaluated.

9. Evaluation of rainbow trout survival and growth at Piledriver Slough should increase.

## ACKNOWLEDGEMENTS

Jack Winters was the field assistant on this project. Rocky Holmes was the primary editor of this report and provided valuable input regarding organization and scientific procedure. Dr. David Bernard provided the more complex statistical analyses, the written explanations to go with them, and the necessary references. He was assisted in this by Dr. John Clark. Robert Clark kept the computers running, Kerri Clark did most of the typing, and Saree Gregory did the graphics. Cal Skaugstad and his crew performed population estimates on rainbow trout in two ponds. Dave Parks, Tim Burke, Don Bee and the rest of the crew at the Clear State Fish Hatchery worked long and hard to provide the majority of the fish that were stocked in Region III. Gary Wall and the crew at the Fort Richardson Hatchery provided the catchable rainbows

in excellent condition. Mike Mills and the staff at RTS provided review of the operational plan and harvest information on stocked lakes through the Statewide Creel Census. Mike Kramer and Jerry Hallberg provided occasional field assistance, helped with stockings, and provided sage management advice.

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# APPENDICES

Appendix Table 1. Number and size of rainbow trout stocked in AYK lakes in 1987.

| Name of water | Number | Size[1] |
|---|---|---|
| South Johnson Lake | 1,400 | Fingerling |
| 31 Mi Pit | 500 | Fingerling |
| 45.5 Mi CHSR Pit | 1,000 | Fingerling |
| Backdown Lake | 500 | Fingerling |
| Bathing Beauty Pond | 500 | Fingerling |
| Bluff Cabin Lake | 10,000 | Fingerling |
| Bullwinkle Lake | 800 | Fingerling |
| Chet Lake | 1,000 | Fingerling |
| Craig Lake | 4,000 | Fingerling |
| Donna Lake | 11,600 | Fingerling |
| Dune Lake | 10,000 | Fingerling |
| Forrest Lake | 7,000 | Fingerling |
| Rockhound Lake | 1,500 | Fingerling |
| No Mercy Lake | 1,500 | Fingerling |
| Doc Lake | 1,500 | Fingerling |
| Geskakmina Lake | 10,000 | Fingerling |
| Ghost Lake | 1,000 | Fingerling |
| Grayling Lake | 500 | Fingerling |
| Jan Lake | 8,800 | Fingerling |
| JRP #1 | 500 | Fingerling |
| Ken's Pond | 600 | Fingerling |
| Koole Lake | 30,000 | Fingerling |
| Les' Lake | 750 | Fingerling |
| Lisa Lake | 10,000 | Fingerling |
| Little Harding Lake | 1,000 | Fingerling |
| Little Donna Lake | 9,400 | Fingerling |
| Lost Lake | 1,000 | Fingerling |
| Manchu Lake | 10,000 | Fingerling |
| Mark Lake | 4,000 | Fingerling |
| Monte Lake | 20,000 | Fingerling |
| Nickle Lake | 1,000 | Fingerling |
| North Twin Lake | 4,000 | Fingerling |
| Rainbow Lake | 25,000 | Fingerling |
| Sansing Lake | 450 | Fingerling |
| | 170 | Subcatchable |
| South Twin Lake | 4,000 | Fingerling |
| Spencer Lake | 5,000 | Fingerling |
| Weazel Lake | 2,000 | Fingerling |
| Quartz Lake | 407,917 | Fingerling |
| | 10,000 | Subcatchable |
| Birch Lake | 34,039 | Subcatchable |
| Piledriver Slough | 12,500 | Catchable |
| | 12,500 | Subcatchable |
| | 35,000 | Fingerling |

- Continued -

Appendix Table 1. Number and size of rainbow trout stocked in AYK lakes in 1987 (Continued).

| Name of water | Number | Size[1] |
|---|---|---|
| Chena Lake | 25,406 | Catchable |
| Harding Lake | 582,021 | Fingerling |
| | 544,200 | Fry |
| Roy's Lake | 10,000 | Fingerling |
| Totals | 544,200 | Fry |
| | 1,236,738 | Fingerling |
| | 56,709 | Subcatchable |
| | 37,906 | Catchable |
| Grand Total | 1,875,553 | |

[1] Fry were stocked in June 1987 at 0.15 g each.
Fingerlings were stocked in late August 1987 at 1.87 to 2.22 g each.
Subcatchables were stocked in late May 1987 at 22.92 to 29.92 g each.
Catchables were stocked from mid-May to mid-June 1987 at 109 to 154 g each.

Appendix Table 2. Number and size of Arctic grayling stocked in AYK waters in 1987.

| Name of water | Number | Size[1] |
|---|---|---|
| Sansing Lake | 1,019 | Catchable |
| West Pond[2] | 25,000 | Fry (Goodpaster Stock) |
| Left O.P.[2] | 16,088 | Fry (Goodpaster Stock) |
| Sheefish Lake | 10,000 | Fry |
| Delta Unnamed | 500 | 4 g |
| Bathing Beauty Pond | 1,000 | 4 g |
| Grayling Lake | 1,000 | 4 g |
| Harding Lake | 640,000 | Fry |
| Dune Lake | 5,000 | 4 g |
| Johnson Road # 1 | 1,000 | 4 g |
| Johnson Road # 2 | 10,000 | Fry |
| Walden Pond | 15,000 | Fry |
| Goodpaster River | 7,989 | 8 g (Goodpaster Stock) |
| Delta Clearwater River | 5,000 | 4 g (Goodpaster Stock) |
| Delta Clearwater River | 5,000 | 8 g (Goodpaster Stock) |
| Engineer Hill Lake | 25,000 | Fry |
| Bolio Lake | 20,000 | Fry |

Continued

Appendix Table 2. Number and size of Arctic grayling stocked in AYK waters in 1987 (Continued).

| Name of water | Number | Size[1] |
|---|---|---|
| Steese Hwy Pits: | | |
| 29.5 Mi | 1,000 | 4 g |
| 30.6 Mi | 1,000 | 4 g |
| 31.6 Mi | 400 | 4 g |
| 33.0 Mi | 10,000 | Fry |
| 33.5 Mi | 10,000 | Fry |
| 34.6 Mi | 8,000 | Fry |
| 35.8 Mi | 1,000 | 4 g |
| 36.6 Mi | 1,000 | 4 g |
| Chena Hot Springs Road Pits: | | |
| 32.9 Mi | 1,000 | 4 g |
| 42.8 Mi | 1,000 | 4 g |
| 45.5 Mi | 10,000 | Fry |
| 47.9 Mi | 800 | 4 g |
| Totals | 799,088 | Fry |
| | 20,700 | 4 g |
| | 12,989 | 8 g |
| | 1,019 | Catchable |
| Grand Total | 833,796 | Grayling |

[1] Catchable size and fry grayling were stocked in late May and mid-June.
Four gram fingerlings were stocked in late August.
Eight gram fingerlings were stocked in mid-September.

[2] Grayling were reared in these ponds until fall and survivors (≈ 20%) were stocked into the Delta Clearwater River.

Appendix Table 3. Number and size of sheefish stocked in AYK waters in 1987.

| Name of water | Number | Size[1] |
|---|---|---|
| Harding Lake | 246,839 | Fingerling |
| | 35 | Broodstock |
| Weigh Station #1 Pit | 200 | Fingerling |
| Weigh Station #2 Pit | 400 | Fingerling |
| Silver Fox Pit | 400 | Fingerling |
| Total | 247,874 | |

[1] The broodstock were 2,400 g fish stocked under the ice in April. The first 150,869 fingerlings were 4 g fish stocked into Harding Lake at the same time. The balance were 11 g fingerlings stocked in late May.

Appendix Table 4. Number and size of Arctic char stocked in AYK waters in 1987.

| Name of water | Number | Size[1] |
|---|---|---|
| Brodie Lake | 1,000 | Fingerling |
| Rangeview Lake | 900 | Fingerling |
| Dick's Pond | 1,000 | Fingerling |
| Ken's Pond | 153 | Fingerling |
| Backdown Lake | 600 | Fingerling |
| Last Lake | 500 | Fingerling |
| Total | 4,153 | |

[1] All char were 4.33 g fingerlings stocked on 18 June.

Appendix Table 5. Number and size of chinook salmon stocked in AYK waters in 1987.

| Name of water | Number | Size[1] |
|---|---|---|
| Bolio Lake | 21,718 | Fingerling |
| Donnelly Lake | 6,000 | Fingerling |
| Little Harding Lake | 10,000 | Fingerling |
| Total | 37,718 | |

[1] Chinooks were 10 g fingerlings stocked on 2 June.

Appendix Table 6. Number and size of coho salmon stocked in AYK waters in 1987.

| Name of water | Number | Size[1] |
|---|---|---|
| 28 Mi Pit | 500 | Fingerling |
| 31 Mi Pit | 500 | Fingerling |
| Birch Lake | 40,000 | Fingerling |
| Chena Lake | 30,000 | Fingerling |
| Dune Lake | 20,000 | Fingerling |
| Geskakmina Lake | 20,000 | Fingerling |
| JRP#1 | 500 | Fingerling |
| Lost Lake | 10,000 | Fingerling |
| Manchu Lake | 5,000 | Fingerling |
| Moose Lake | 8,000 | Fingerling |
| Quartz Lake | 168,500 | Fingerling |
| Eight Mi Lake | 15,000 | Fingerling |
| Hangar Pit | 2,600 | Fingerling |
| Sansing Lake | 200 | Fingerling |
| Round Pond | 400 | Fingerling |
| Long Pond | 700 | Fingerling |
| Total | 321,900 | |

[1] All coho salmon stocked in Dune, Geskakmina Lake, and the first 85,000 stocked into Quartz Lake were 2 g fingerlings stocked under the ice in late April. The balance were 5 g fingerlings stocked in early June.

Appendix Table 7. Stocking request summary for Region III, 1988.

| Species | Size | Number Requested |
|---|---|---|
| Rainbow Trout | Catchable | 59,600 |
| Rainbow Trout | Subcatchable | 110,000 |
| Rainbow Trout | Fingerling | 1,000,000 |
| Coho Salmon | Fingerling | 264,600 |
| Chinook Salmon | Fingerling | 45,400 |
| Sheefish | Fry | 225,000 |
| Arctic Char | Fingerling | 72,600 |
| Lake Trout | Fingerling | 49,400 |
| Grayling | Fingerling | 14,350 |
| Grayling | Fry | 75,000 |
| Kokanee | Fry | 500,000 |